

BELLCOMM, INC.

SUBJECT: Critical Design Review of ATM
Experiment S-054, X-Ray Spectro-
graphic Telescope - Case 620

DATE: July 15, 1968

FROM: S. H. Levine
T. C. Tweedie, Jr.

MEMORANDUM FOR FILE

The authors participated in the Critical Design Review (CDR) of the AS&E (American Science and Engineering Co.) S-054 X-Ray Spectrographic Telescope experiment held at Cambridge, Massachusetts, on June 24-27, 1968. The purpose of the CDR was to examine in detail the approaches, plans, designs and specifications prepared by the experiment contractor prior to initiation of the hardware manufacturing phase of instrument development.

Personnel from AS&E presented a detailed review of the X-ray telescope operations and subsystems including the AS&E experiment interfaces with ATM systems. Appendix A lists the data package which was distributed to the review board for evaluation. Copies of the documentation listed are available from the authors. Comments on the material presented were offered by the CDR attendees which included representatives of MSFC, MSC, KSC and Headquarters.

Comments and observations on the CDR generated by the authors are contained in Appendix B.

S. H. Levine
S. H. Levine

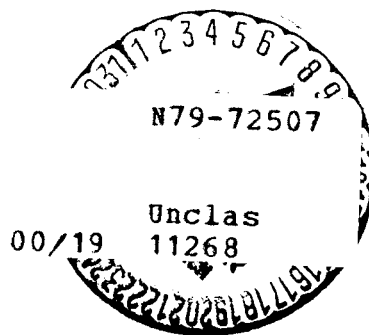
T. C. Tweedie, Jr.
T. C. Tweedie, Jr.

1024-SHL
1021-TCT-Jd

Attachments

(NASA-CR-97059) CRITICAL DESIGN REVIEW OF
ATM EXPERIMENT S-054, X-RAY SPECTROGRAPHIC
TELESCOPE (Bellcomm, Inc.) 5 p

REF ID: A66000	CR 97059	(NASA CR OR TMX OR AD NUMBER)	(CATEGORY)
UNCLASSIFIED			



CENTRAL FILES
EXTRA COPY

BELLCOMM. INC.

APPENDIX A

ATM/S-054 CDR DATA PACKAGE

GROUP 1 DESCRIPTION OF EXPERIMENT OPERATION

- Item 1 Design and Performance Specification (DPS), ASE-1600-A
- Item 2 Design ECP's
 - 2A ATM/S-054 ECP-Discriminator Level Setting
 - 2B AS&E Review of 50M02429 Revision A (ATMPF-141B)
 - 2C ATMPF-102 Revision A dated March 1968, Engineering Change Proposal for Camera Design Change
- Item 3 Operating Procedures

GROUP 2 IDENTIFICATION OF EXPERIMENT SUBSYSTEMS

- Item 1 Functional Block Diagrams of ATM Subsystems
- Item 2 End Items, Illustrated

GROUP 3 ATM/S-054 DRAWINGS

- Item 1 ATM/S-054 Drawing Tree and Drawing List
- Item 2 Interface Control Drawings (12)
- Item 3 Assembly and Major Subassembly Drawings (36)

GROUP 4 DEVELOPMENT AND PROTOTYPE TEST DATA LIST

- Item 1 Scientific Data
- Item 2 Electrical Data
- Item 3 Mechanical Data (including thermal and stress analysis)
- Item 4 Report on Acoustical Tests

GROUP 5 RELIABILITY

- Item 1 Safety Analysis Summary
- Item 2 Reliability Parts List
- Item 3 Reliability Materials List

GROUP 6 IDENTIFICATION OF ECE

- Item 1 ATM/S-054 Experiment Checkout Equipment (ECE)

EIDD 50M02429 Revision A Apollo Telescope Mount Experiment Interface Defining Document S-054 X-Ray Spectrographic Telescope, May 10, 1968

BELLCOMM, INC.

APPENDIX B

COMMENTS AND OBSERVATION ON THE S-054 X-RAY

SPECTROGRAPHIC TELESCOPE CRITICAL DESIGN REVIEW

1. On June 6, AS&E conducted a rocket flight with a grazing incidence X-ray telescope similar to the one currently planned for ATM. A comparison of both experiments is given as follows:

	<u>Solar Rocket Flight</u>	<u>ATM</u>
Mirror Config.	Single Paraboloid/ Hyperboloid	Double Paraboloid/ Hyperboloid
Focal Length	52"	84"
Collecting Area	34 cm ²	44 cm ²
Film	Modified Pan X and Kodak 103-0	Modified Pan X
Flight Time	300 seconds	56 days

The rocket launch was based on a flare alert communicated to the launch complex by the Environmental Science Services Administration in Boulder, Colorado. The quality of instrument pointing control during the mission (in the order of +1 arc sec) contributed to the excellent photographic results that were obtained. This flight confirmed the acceptability of the transmission grating for the ATM telescope and the spectral range of filters which will ultimately be selected for the S-054 experiment. As a result of the excellent photographs obtained with the Modified Pan X film, AS&E has adopted this less radiation-sensitive film for use with their ATM experiment.

2. Grating development and improvement is continuing at AS&E in parallel with telescope development and manufacture. Although present gratings are adequate for ATM purposes, AS&E feels that other promising manufacturing materials and techniques that may improve the performance and quality of these X-ray gratings should be explored.

3. The grazing incidence mirrors, which focus the X-rays in the telescope, have been found to be sensitive to the quality of surface polish. AS&E is working with the mirror vendor to obtain proper surface finishes for the mirrors. The solution for this manufacturing problem appears to be well underway. It should be noted that Harvard College Observatory seems to be experiencing similar difficulties with mirror surfaces, although the HCO experiment operates in the ultraviolet rather than the X-ray region.

APPENDIX B

The solution for suitable mirror surfacing techniques should be coordinated between the PIs to avoid costly duplication of effort.

4. A total of four film magazines are required for this experiment on the ATM mission. The current plans are to use two film magazines with image intensifiers and two film magazines with beryllium filters in place of the image intensifiers.

5. The AS&E magazine size with an image intensifier is 6" x 12" x 24-1/4". The magazine is currently designed to sustain a 10g load along the longitudinal axis (24-1/4") and a 3g load along the lateral axis (12"). The physical geometry of the LM crew provisions stowage module (CPSM), designated as the location for ATM cameras and magazines during the launch phase, requires that the S-054 film magazine be stored with its lateral axis aligned with the AAP-4 launch vehicle thrust vector. (The maximum internal height of the CPSM is 20 inches.) The maximum anticipated launch loads in the LM are well in excess of the lateral axis capability of the magazines. This will require either a change to the magazine design or relocation of the three AS&E magazines for the launch phase of AAP-4. The alternatives should be evaluated by AS&E and MSFC.

6. AS&E requires that experiment S-054 be maintained at 70°F to achieve satisfactory performance. The experiment is designed to radiate heat to the ATM experiment package wall which is maintained at a nominal temperature of 50°F. To reduce thermal gradients in the experiment, internal electrical heaters are used to heat portions of the experiment. Following launch, it is estimated that from 12 to 24 hours will be required to attain and stabilize the experiment temperature at 70°F from an initial temperature of 50°F.

During EVA film camera retrieval, the experiment electrical power will be disabled for astronaut protection. The sequence for EVA film retrieval includes:

- a. An EVA preparation period including pre-breathing, film transfer, suit checkout and suit donning activities estimated to be approximately 2.5 hours.
- b. An EVA period currently estimated to be 3 hours maximum.

APPENDIX B

- c. A post EVA period currently estimated to be approximately 1 to 1.5 hours which includes suit doffing, film handling and storage and crew return to a preselected crew station. At least 2.5 hours are required subsequent to the EVA sequence for eating, rest, relaxation and personal hygiene.

Thus the ATM Control and Display Console may be unattended and the experiment heaters may be disabled for a period of up to 9.5 hours. In this time period the experiment will cool down to a temperature approaching the 50°F ATM canister temperature. Thermal analysis is needed to determine the time required for initial thermal stabilization following launch, and following each EVA (3 film replacement periods during the 56-day mission). The time required to achieve thermal stabilization may affect the scheduled timeline for solar observation by this experiment.

7. The MSFC low temperature (-40°F) and high temperature (165°F) rack operational environmental qualification test requirements are currently unacceptable to AS&E. The AS&E Main Electronics Assembly (MEA) which is located on the rack is designed to operate in a temperature range of 32 to 100°F. Redesign is expected to accommodate MSFC requirements.

8. MSFC has relocated the MEA from the top of the rack to a lower quarter panel (Rack Zone 22). This change will have to be evaluated by AS&E to determine the effect of thermal and induced load changes on the MEA.

9. MSFC requirements for fastening the S-054 instrument mounts to the ATM spar differ from the AS&E design provisions for instrument tie-down. Minor remachining of the instrument may be required by AS&E to accommodate MSFC's requirements.

10. The AS&E Experiment Interface Defining Document (paragraph 13.1.1) required prelaunch and orbital film storage temperatures to be between 0° and 40°F. This requirement has been established to preclude degradation of the film emulsion which may occur as a result of long duration elevated temperature exposure. Goddard Space Flight Center's S-056 X-Ray experiment, being built by MSFC and using the same film as S-054, does not have a comparable requirement. AAP currently does not have the capability to satisfy this temperature requirement. AS&E should assess the need for this requirement in light of the potential impact to AAP.